P2.4 COMPARISONS OF RUC 20-KM AND 40-KM FORECASTS FOR 24 MAY 2000

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1. INTRODUCTION

The Rapid Update Cycle (RUC), running at the National Centers for Environmental Prediction (NCEP) and developed at the Forecast Systems Laboratory (FSL), has become an important forecast tool for predicting environments conducive to development of severe convective weather. The 1-h assimilation cycle allows for the rapid ingest of asynoptic weather observations and hourly forecasts to 6 h, and, every 3 h, forecasts are made out to 12 h . The operational 40-km version of this model has been available since 6 April 1998, and the 20-km version will be operational in 2001. The RUC generates fields useful to severe weather forecasting every hour, including convective available potential energy (CAPE), convective inhibition (CIN), lifted index (LI), and storm-relative helicity.

On 24 May 2000, there was a severe weather outbreak across the Midwest into the eastern United States, with large hail, severe winds and heavy rain reported from Oklahoma eastward to New York and southward to North Carolina. At the conference, we will investigate the performance of the 40-km RUC, and then contrast it with forecasts made for the same time with the new 20-km RUC. In this paper, we present some information on the 20-km and 40-km versions and on the 24 May 2000 case.

Through these experiments, we will examine what improvements from RUC guidance might be expected for forecasters in the future with a more complete data assimilation and an advanced version of the RUC model.

2. VERSIONS OF THE RUC

2.1 The 40-km RUC

The version of the RUC running at NCEP on 24 May 2000 had a grid spacing of 40 km, with 40 hybrid isentropic-sigma vertical levels. The analysis scheme was Optimum Interpolation (OI) with intermittent data assimilation done on an hourly basis, and a new 12-h forecast every 3 h. Many different kinds of data are incorporated into the RUC: radiosonde, wind profiler, Velocity Azimuth Display (VAD) winds, ACARS aircraft winds and temperatures, surface, marine, satellite precipitable water and cloud-drift winds.

The RUC also uses daily lake (14 km) and sea surface temperatures (50 km), as well as monthly vegetation fraction information (0.14^{o}). In the model, a mixed-phase cloud microphysics scheme provides explicit forecasts of mixing ratios for cloud water, rain water, snow, ice, and graupel. A multilevel soil/vegetation/snow model for the surface is cycled every hour for six levels down to 3 m below the surface. Turbulence was handled with the Burk-Thompson explicit TKE scheme (Burk and Thompson, 1989). More detail about the 40-km operational RUC can be found in Benjamin et al. (1999).

2.2 The 20-km RUC

. A 20-km version of the RUC (Benjamin et al. 2001) is being implemented at NCEP in summer 2001. Improvements are not limited to just an increase in the horizontal resolution. The analysis has been changed to a 3-d variational system (Devenyi et al. 2001), to better utilize unorthodox observations, such as the GPS-IPW which is included in the 20-km data assimilation. Assimilation of GOES cloud-top presssure has been added (Kim and Benjamin 2001). A more sophisticated land-surface model with higher resolution vegetation and soil data should improve important interactions in the lowest layers of the model, and updated microphysics (Brown et al. 2000) and convective parameterizations will improve the RUC precipitation forecasts. Testing of the 20-km RUC has shown a better capability for forecasting convective precipitation, both in detail for individual cases and in overall threat scores and bias (Schwartz and Benjamin 2001). A comparison of the terrain over the western United States between the 40-km and 20-km resolution is shown in Figs.1 and 2. The 20-km RUC will be run retrospectively for 24 May 2000

3. 24 MAY 2000 OBSERVATIONS

Figure 3 shows the majority of the severe weather reports from 24 May 2000, most of which happened during the afternoon and early evening. A swath of wind and hail damage (Fig. 3) can be seen from the KS/OK/MO/AR area across the country to the Mid Atlantic and Northeastern states. Flow at low levels (Figs. 4 and 5) was broadly confluent (and frontogenetical) across the Southern Plains into the Ohio Valley and Mid-Atlantic region.

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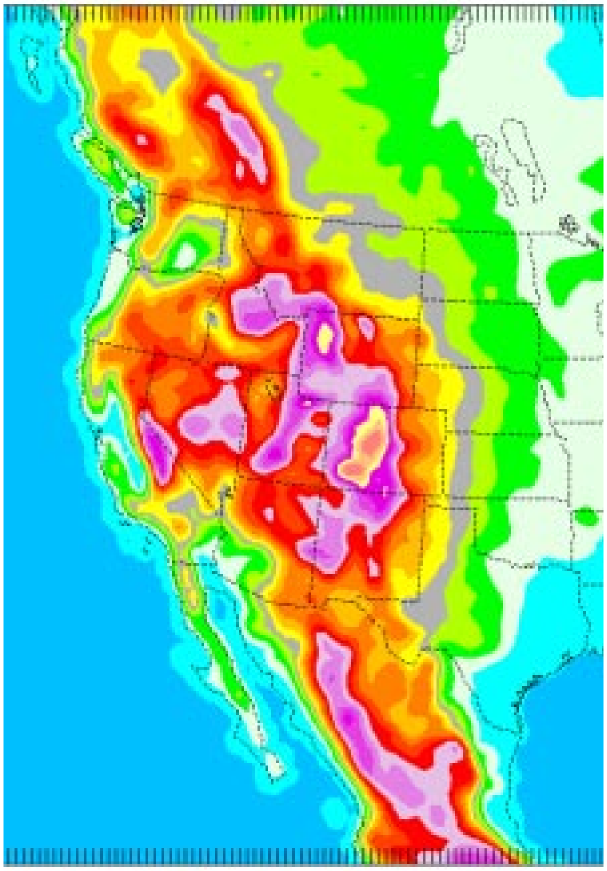

Figure 1. The 40-km RUC terrain over the western U. S.

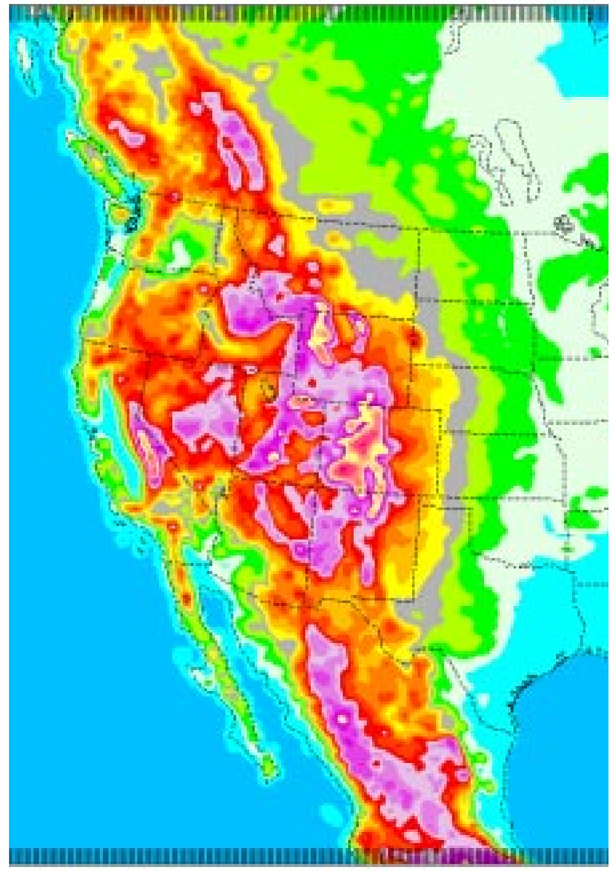

Figure 2. Same as figure 1, but for 20-km.

The very moist flow south of this confluence zone is capped, as is evident by warm, dry air at 850 mb (Fig. 5; dew point rather than depression is plotted) over the Southern Plains and eastward into the Southeast.

At 500 mb (Fig. 6), an unseasonably strong, well-defined jet streak at 1200 UTC is present across the Midwest into the mid-Atlantic region, with its left exit region over PA and NY. Noteworthy is that 500 mb temperatures in this exit region are below -15^{o}C.

As evident in these fields, there is potential for severe weather activity. The experiments to be shown at the conference will show differences in 20-km vs. 40-km RUC forecasts for this case.

4. PLANS

We will illustrate the use of the RUC in severe weather forecasting with this case study from the spring of 2000. The utility of CAPE, CIN, LI, and storm-relative helicity in anticipating correctly the character of later convection will also be assessed.

An examination of the output from both versions of the model will help educate forecasters in differences between the old RUC and the new RUC.

The 20-km RUC is scheduled to be implemented at NCEP in 2001. This newer version will have additional enhancements including three-dimensional variational (3DVar) analysis and a cloud/hydrometeor analysis using satellite observations combined with RUC explicit cloud forecasts. New data sources will continue to be included as they become available on a routine basis. Improved physical parameterizations such as cloud microphysics (freezing drizzle), surface physics (frozen soil, high-resolution soil and surface datasets), and turbulence physics are also scheduled to be in the new version. A 10-12 km RUC is planned for 2002.

5. REFERENCES

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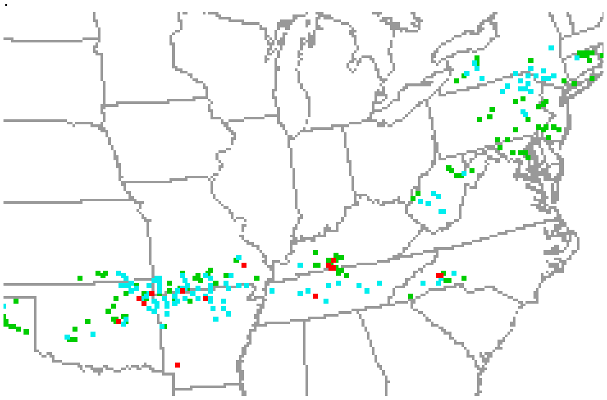

Figure 3. Severe weather reports for 24 May 2000.

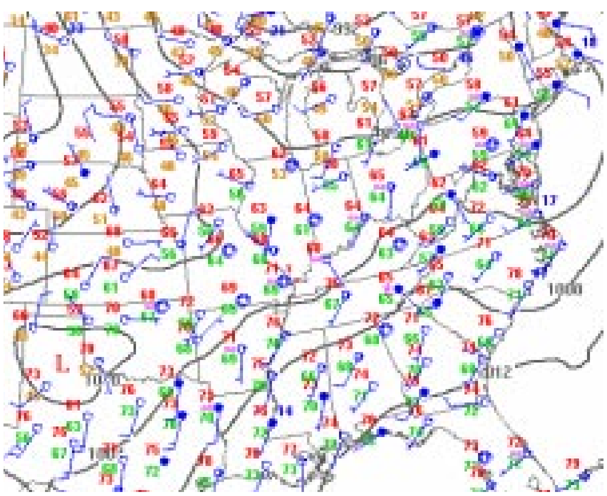

Figure 4. Surface observations for 1200 UTC 24 May 2000.

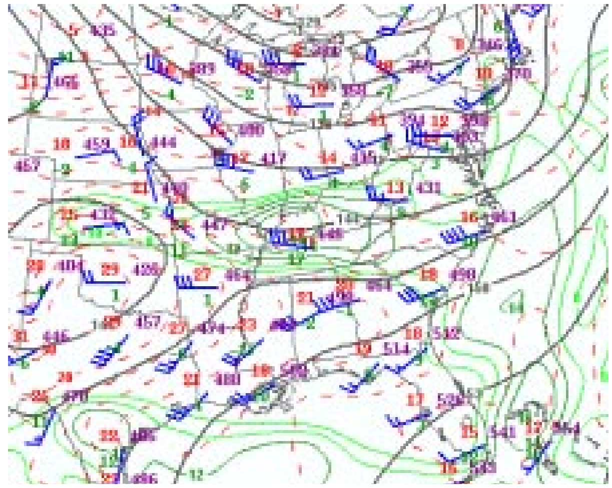

Figure 5. 850 hPa observations for 1200 UTC 24 May 2000.

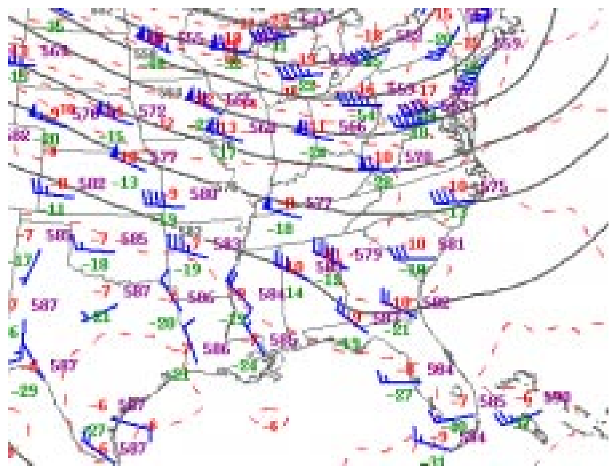

Figure 6. 500 hPa observations for 1200 UTC 24 May 2000.